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RESEARCH MEMORANDUM

TANK INVESTIGATION OF THE GRUMMAN JRF-5 AIRPLANE WITH A SINGLE HYDRO-SKI AND AN EXTENDED AFTERBODY

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Langley Field, Va.

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RESEARCH MEMORANDUM

TANK INVESTIGATION OF THE GRUMMAN JRF-5 AIRPLANE WITH A SINGLE HYDRO-SKI AND AN EXTENDED AFTERBODY

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SUMMARY

Results from a tank investigation of a $\frac{1}{8}$- size powered dynamic model of the Grumman JRF-5 airplane fitted with a single hydro-ski and an extended afterbody are presented. A comparison with results of a previous investigation with tandem hydro-skis indicates that the afterbody extension in place of the tail ski reduced the maximum resistance 10 percent. A further reduction of 3 percent was obtained by removal of the wing-tip skids. The effects on longitudinal stability were negligible.

INTRODUCTION

An experimental hydro-ski landing gear on a Grumman JRF-5 amphibian for operation in water, snow, and ice was developed by the Edo Corporation for the U. S. Air Force. Results of NACA tank tests of the modification are presented in reference 1 and full-scale tests by the Edo Corporation are described in reference 2.

A similar project was undertaken by the Edo Corporation for the Bureau of Aeronautics, Department of the Navy, for water operation only. Since the tail ski and wing-tip skids of the Air Force installation were primarily for the snow and ice conditions, consideration was given to replacing the tail ski with an extension to the hull afterbody and omitting the tip skids. This paper presents the results of a brief investigation in Langley tank no. 2 of the resistance and stability characteristics obtained with the changes incorporated in the powered dynamic model.

DESCRIPTION OF MODEL

The model was the same as that used in the tests described in reference 1 except that the tail ski was removed and the extension added to the afterbody. For part of the tests the wing-tip skids were

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also removed. The general arrangement of the model with these modifications is shown in figure 1. Photographs of the model are shown in figure 2.

The afterbody extension had a dead rise of 25° from the second step aft to the rudder parting line (station 424). This extension was faired into the afterbody as shown in figure 3.

APPARATUS AND PROCEDURE

The test setup with the model floating at normal gross weight (8,000 lb, full size) is shown in figure 4. The model was free to trim about the center of gravity and free to rise but was restrained laterally and in roll and yaw.

The elevators were varied over a range of deflections from -30° to 0°. A flap deflection of 30° was used for all tests.

The variation of trim (the angle between the undisturbed water surface and the forebody keel) with speed for the normal center of gravity ($0.226\bar{c}$, where $\bar{c}$ is the mean aerodynamic chord) and several elevator settings was determined during runs at an acceleration of 1.0 foot per second per second and with full power (3750 lb static thrust, full size).

The resistance, as determined in the tests, is defined by the equation

$$R = T_e - T_x$$

where

R total resistance, pounds

T_e effective thrust, pounds

T_x excess thrust, that is, resultant horizontal force with power on and model in water, pounds

The excess thrust was determined from constant-speed runs with the model in the water fixed in trim. The range of fixed trims tested at each speed corresponded to the range of stable trims found in the stability tests.

The effective thrust is defined by the equation

$$T_e = D_c + R_H$$

where

D_c air drag of model with propellers fixed, pounds

R_H resultant horizontal force with power on and model in air, pounds

The values D_c and R_H were determined at various speeds with the model just clear of the water at 0° trim and the elevators set at 0°.

Partial power corresponding to 62.5-percent static thrust (2340 lb thrust, full size) was used for the resistance tests to permit comparison with the results of reference 1.

RESULTS AND DISCUSSION

Sequence photographs of a typical take-off run with the wing-tip skids removed are shown in figure 5. Trim tracks for various elevator deflections are shown in figure 6. Trim tracks from reference 1 are included in this figure for comparison. The wing-tip skids made no noticeable difference in the trim tracks.

In all cases the model rose onto the ski at a speed corresponding to between 20 and 30 miles per hour (full size). Instability, because of emergence at too low a speed to provide sufficient planing lift for sustentation, was encountered over a small range of speeds. The emergence instability oscillations appeared to occur at a more gradual rate for the present configuration than for the configuration of reference 1; the instability was overcome by increasing the acceleration to 2.5 feet per second per second whereas an increase in acceleration to 3.5 feet per second per second was required for the previous configuration. The excess thrust available in the full-size airplane is ample to provide this acceleration.

At preemergence speeds there was no difference in longitudinal stability between the two configurations although the trims obtained with the present configuration were lower for all elevator settings except 0°. This reduction in trim might cause an increase in the amount of forebody spray entering the propellers in the speed range from 10 to 15 miles per hour although the spray characteristics, in general, appeared to be the same as for the previous configuration. The trims and stability after emergence were substantially the same since at higher speeds only the main ski was in contact with the water for both configurations.

The extended afterbody did permit the ski to emerge at an elevator setting of 0°; whereas the configuration of reference 1 did not emerge at this setting. This difference is of little practical significance, however, because porpoising occurred almost immediately after emergence.

Curves of total resistance converted to full-size values are shown in figure 7. The total resistance includes both the water resistance and the air drag of the model and is the envelope of minimum resistance obtained from the fixed-trim tests over the stable range of trims. A curve showing the estimated available thrust for the airplane is included.

The resistance at the lower speeds was only slightly less with the afterbody extension than with the tail ski. At speeds just before ski emergence, however, a considerable reduction in resistance was obtained. This reduction continued up to the speed at which the afterbody extension or the tail ski (reference 1), came clear of the water; as would be expected, no difference in resistance was obtained above this speed. The reduction in maximum resistance was about 10 percent.

Removal of the wing-tip skids made no difference in resistance at the very low speeds but did cause a further reduction in resistance at the speeds just before emergence. This reduction amounted to 3 percent of the maximum resistance. At speeds above emergence there was no difference since the wing-tip skids were clear of the water.

CONCLUSIONS

Results from a tank investigation of a model of the Grumman JRF-5 airplane fitted with a single hydro-ski and an afterbody extension compared with results from a previous tank investigation with tandem hydro-skis indicated the following conclusions:

1. Replacing the tail ski with an afterbody extension reduced the maximum resistance 10 percent.

2. Removal of the wing-tip skids gave a further reduction in maximum resistance of 3 percent.

3. The effects of the modifications on the longitudinal stability were negligible.

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REFERENCES

1. Wadlin, Kenneth L., and Ramsen, John A.: Tank Investigation of the Grumman JRF-5 Airplane Fitted with Hydro-Skis Suitable for Operation on Water, Snow, and Ice. NACA RM L9K29, 1950.

2. Anon.: Summary Report on USAF Project MX-940. Rep. 2719, Edo Corp., April 5, 1949.

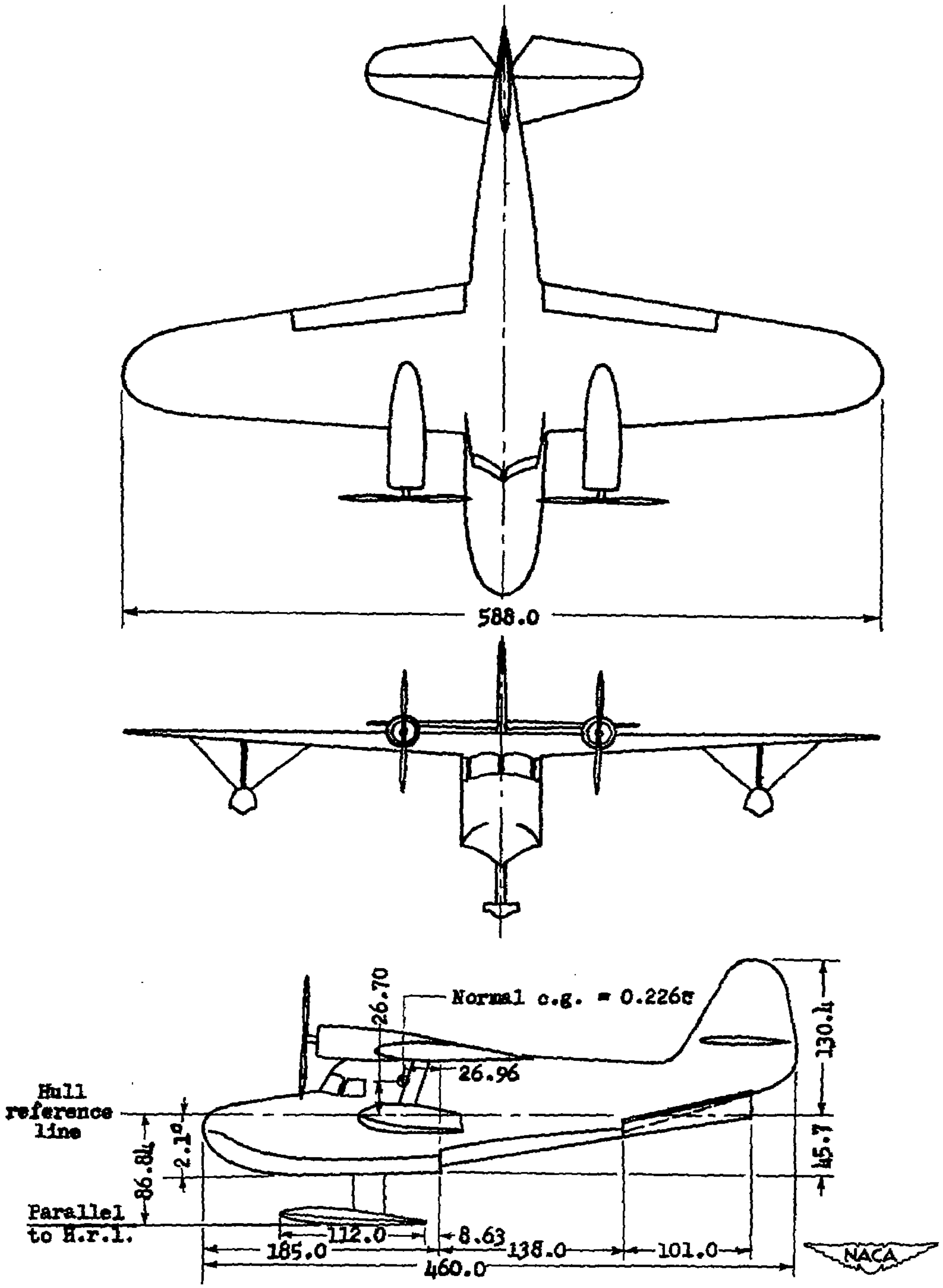

Figure 1.- General arrangement of $\frac{1}{8}$-size powered dynamic model of Grumman JRF-5 airplane with single hydro-ski and afterbody extension. (Dimensions are inches, full size.)

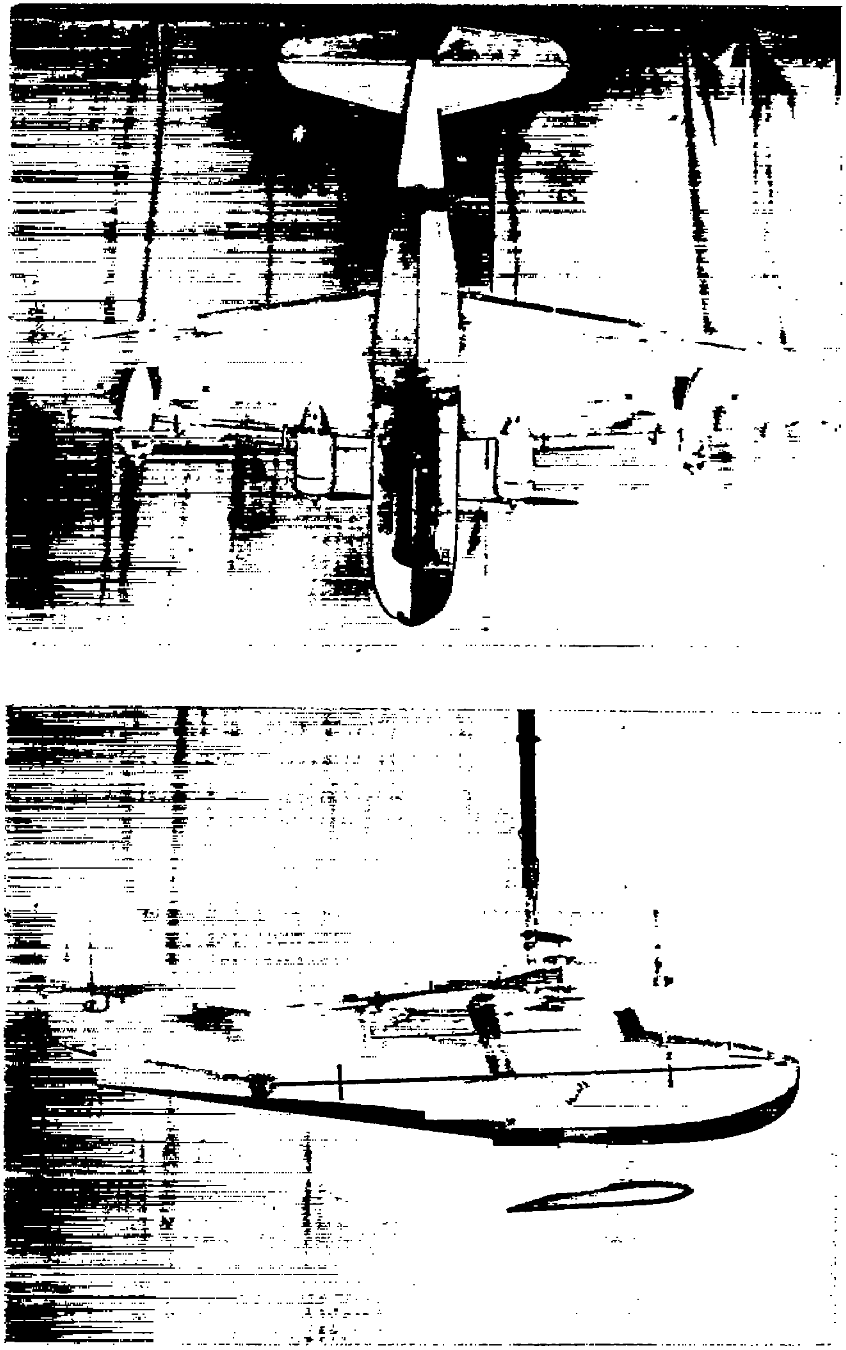

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Figure 2.- Photographs of $\frac{1}{8}$-size powered dynamic model of Grumman JRF-5 airplane with single hydro-ski and afterbody extension.

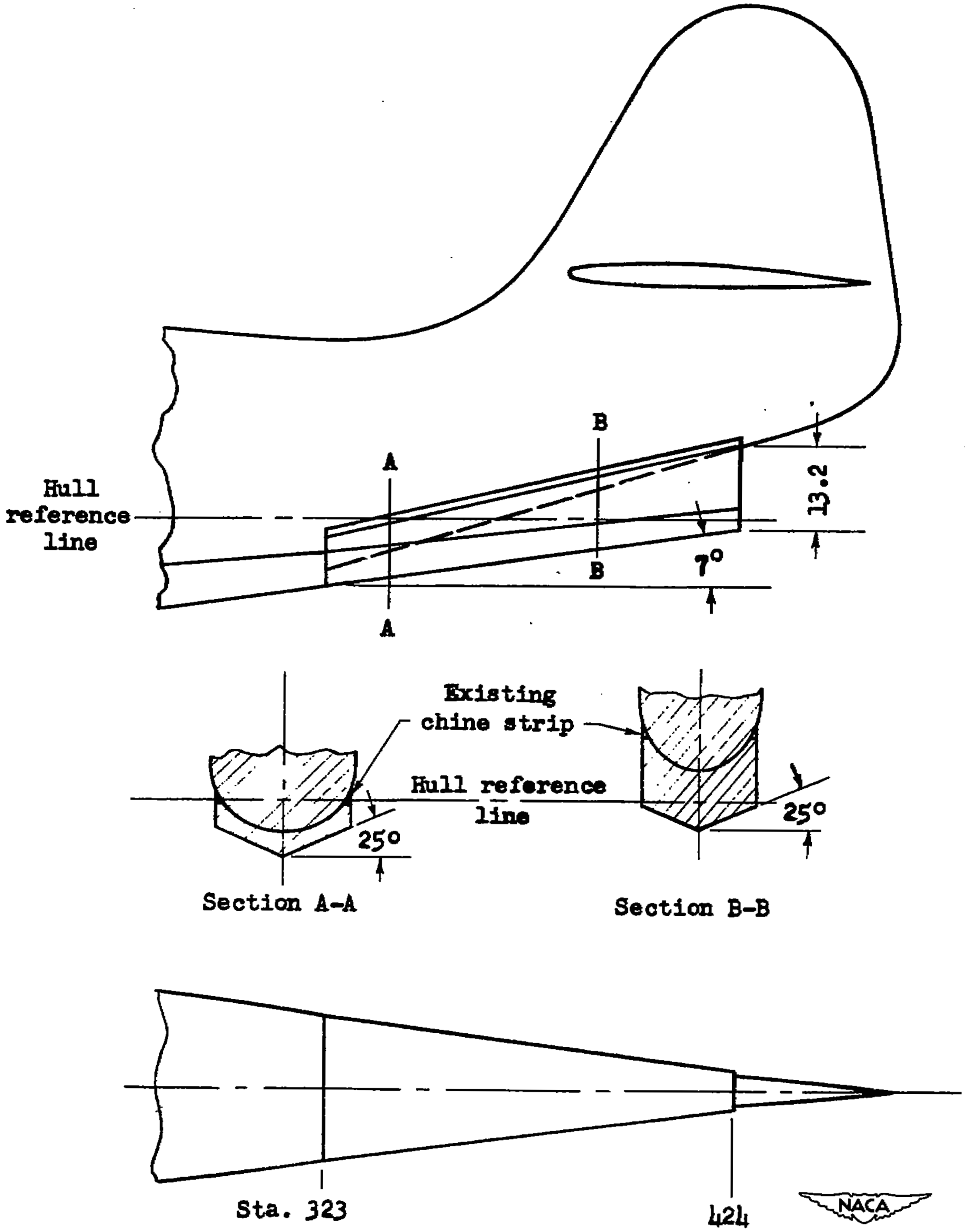

Figure 3.- Details of afterbody extension. (Dimensions are inches, full size.)

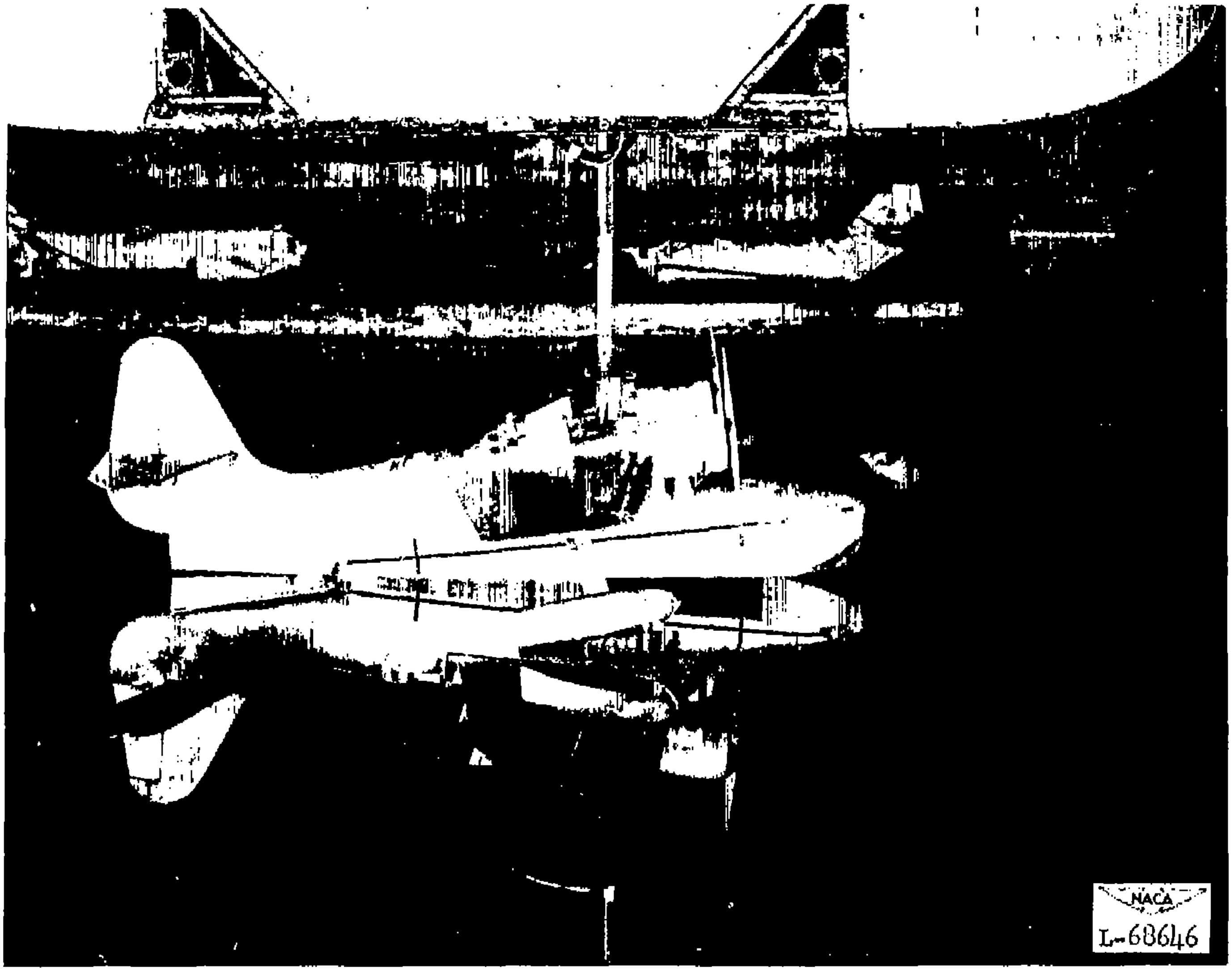

Figure 4.- Test setup showing model floating at normal gross weight.

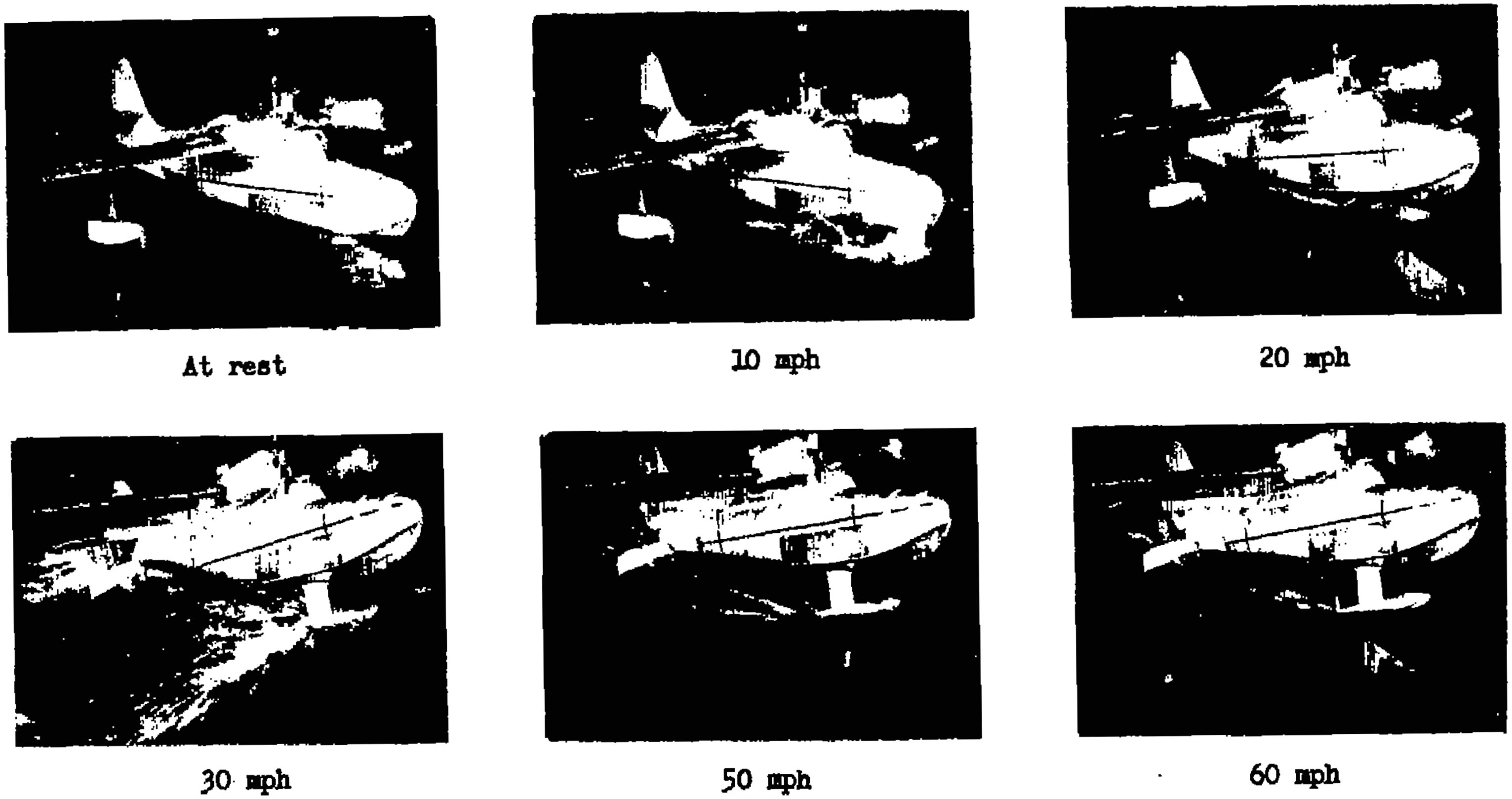

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Figure 5.- Sequence photographs of a typical take-off run. (Values are full size.)

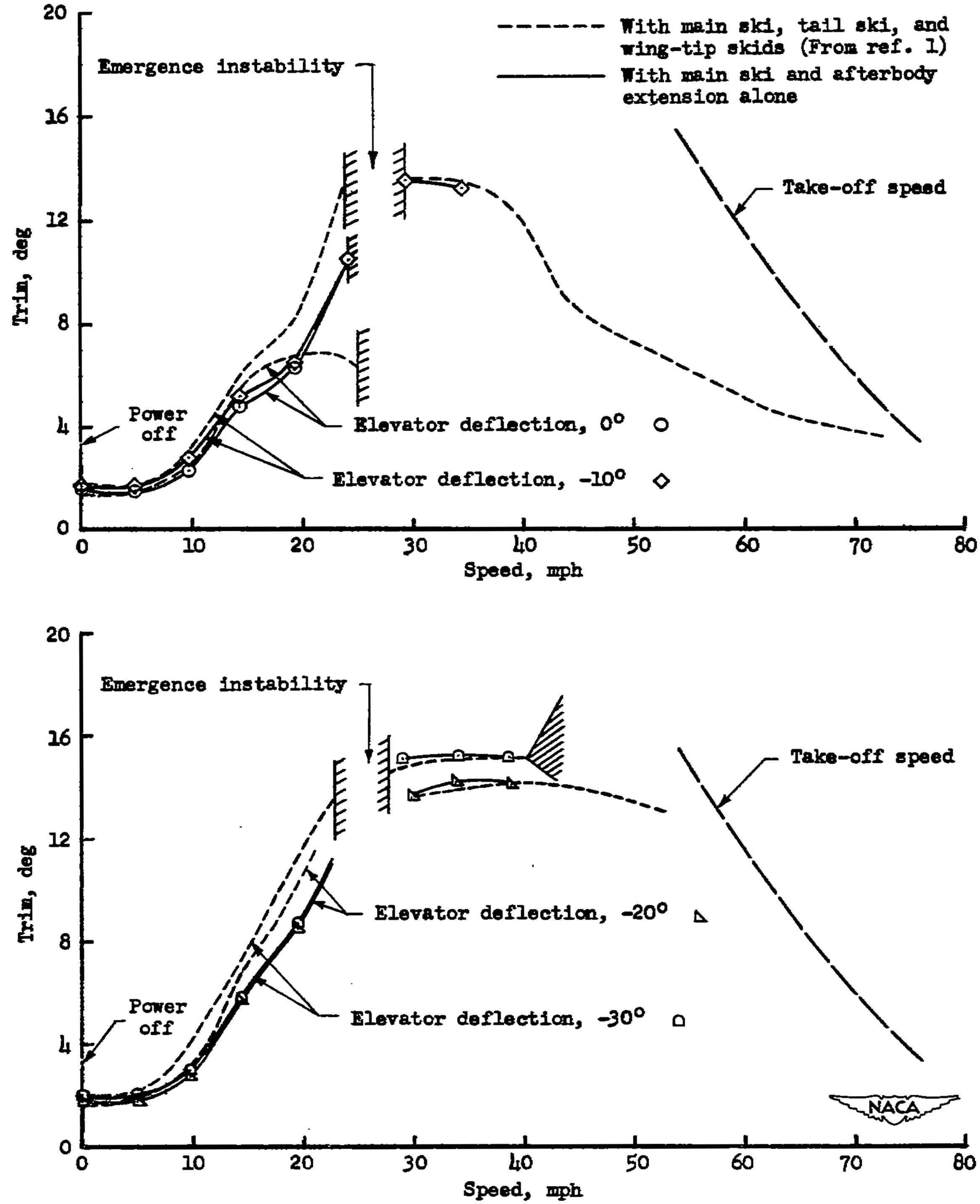

Figure 6.- Variation of trim with speed. (Values are full size.)

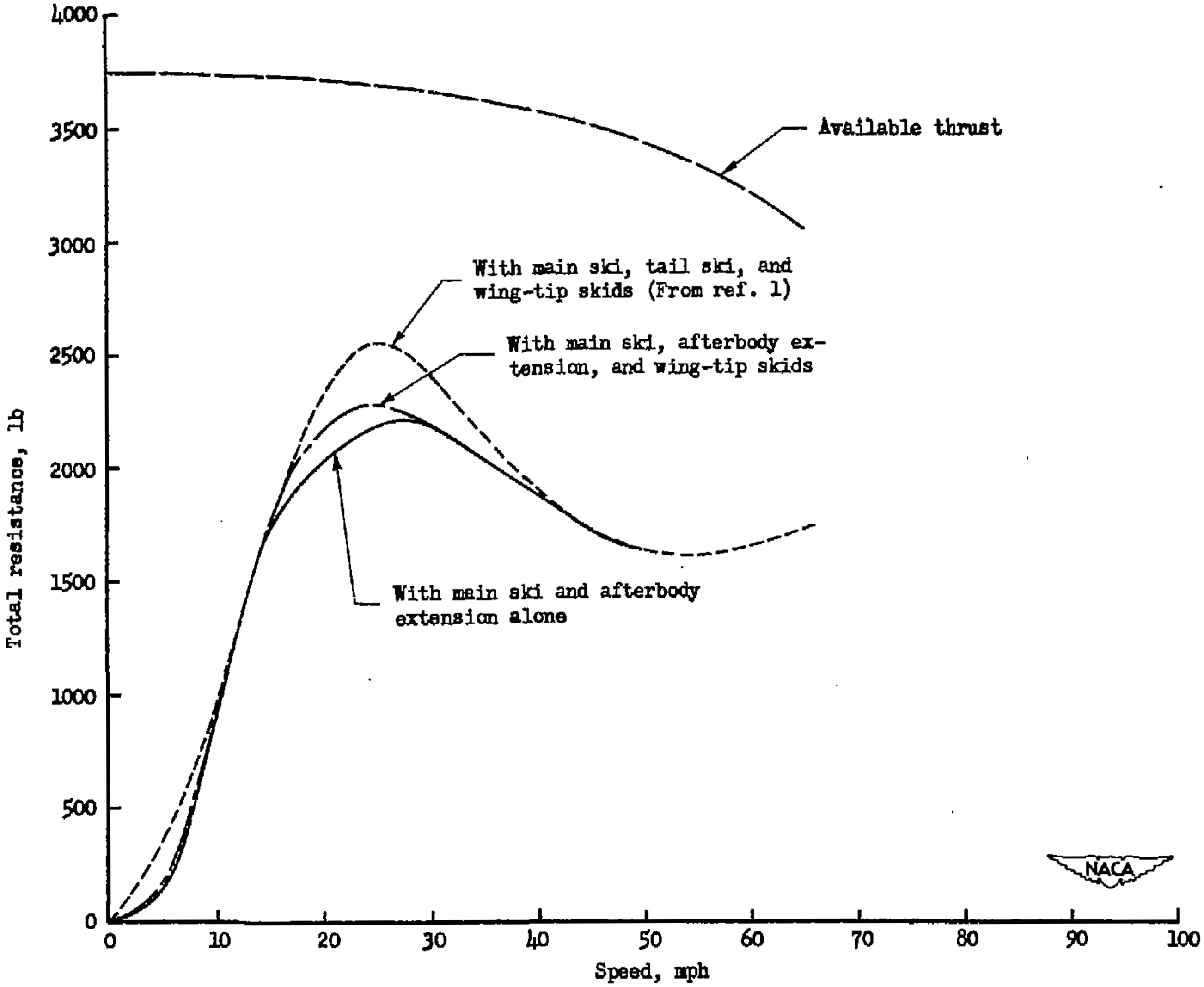

Figure 7.- Variation of total resistance with speed. (Values are full size.)

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